

EEG Processing Project Laboratory

March 15, 2016 3:30 – 5:00 pm

Purpose

The purpose of this laboratory is to gain experience acquiring multi-channel EEG data for a set of experiments where the subject moves the left or right extremity while relaxing the contralateral extremity. The objective is to develop a brain computer interface (BCI) that can be used to control a wheelchair/robot arm/environmental controller. We shall consider a motor cortex paradigm rather than a cognitive paradigm (P300). This can be most easily done by rubbing the thumb against the fingers vigorously. The student will then take these data records and extract selected features (either those proposed in the literature or from personal preference). These features can then be used as independent variables in a model that can predict whether the left or right upper motor neurons are being activated (right or left fingers being moved).

Laboratory Experiments

1. The subject will be instrumented with 4 electrodes at C3, C4, P3 and P4 with linked ear references and a ground on forehead
2. Select one of the Clevedmed programs, EEG I, EEG II or Alertness detection
3. Subject must be seated comfortably at lab bench with both arms (elbows) supported on table.
4. Subject will keep eyes open
5. Create a random sequence of left and right (e.g. flip a coin with heads being LEFT tails being RIGHT). Write down that order until you have 7 LEFT and 7 RIGHT.
6. Make sure data collection setup is for 200 Hz sample rate 4 channels. Check what the filter settings are. Should be 1 to 70 Hz
7. Ask subject to move fingers for 10 seconds for LEFT side and view on screen
8. Ask subject to move RIGHT side and view on screen.
9. Set the system up for data storage. Ask subject to move the first side indicated on your sequence list for 10 sec. and store data
10. Repeat this step until you have completed and stored the 14 records.
11. Ask subject to close eyes.
12. Repeat 9 and 10 until you have 3 LEFT and 3 RIGHT recordings.
13. Check that stored data is OK by viewing under Excel
14. Store data on your memory device.

Post Processing

Once you have viewed the data under Excel (one channel at a time) write a Matlab program that displays the 4 channels (adding an offset to space them). Are there eye blinks or other artifacts? Modify the program by bandpass filtering the data to include only alpha and beta bandwidths and display the results. Did you get rid of the artifacts?

Feature Extraction

Break the 10 second record into 10 1 sec records and obtain your selected features for each 1 second epoch. Reject the first and last epochs or any epochs that don't have stationary EEG data. This should give you about 50 values for each side control for each variable. You can use spectral power in a band, or for individual frequencies, power ratios left to right, left to left, coherence between channels, bispectra, etc.

Data Analysis

Compare the feature statistics for left movement vs right movement using descriptors (means and standard deviations of each feature) and test significant differences using simple (or more complex tests) such as t-test.

Creating BCI

Create a model (machine learning) using a limited set of selected features (start with the ones that have different values left to right as shown above). The model can be as simple as a multiple linear regression equation with the features as independent variables and outcome as dependent. Train or establish your model using the first half of your data and test it with the second half.

Report

Write up your report with an introduction citing published literature and statement of problem, methods, results, discussion and conclusions much like a standard journal article.